2 DETERMINING WORST-CASE SCENARIOS

In Chapter 2

2.1 Definition of Worst-Case Scenario

A worst-case release is defined as:

- The release of the largest quantity of a regulated substance from a vessel or process line failure, and
- The release that results in the greatest distance to the endpoint for the regulated toxic or flammable substance.

You may take administrative controls into account when determining the largest quantity. Administrative controls are written procedures that limit the quantity of a substance that can be stored or processed in a vessel or pipe at any one time or, alternatively, procedures that allow the vessel or pipe to occasionally store larger than usual quantities (e.g., during shutdown or turnaround). Endpoints for regulated substances are specified in the rule (40 CFR 68.22(a), and Appendix A to part 68 for toxic substances). For the worst-case analysis, you do not need to consider the possible causes of the worst-case release or the probability that such a release might occur; the release is simply assumed to take place. You must assume all releases take place at ground level for the worst-case analysis.

This guidance assumes meteorological conditions for the worst-case scenario of atmospheric stability class F (stable atmosphere) and wind speed 1.5 meters per second (3.4 miles per hour). Ambient air temperature for this guidance is 25 ^{o}C (77 ^{o}F). If you use this guidance, you may assume this ambient temperature for the worst case, even if the maximum temperature at your site in the last three years is higher.

The rule provides two choices for topography, urban and rural. EPA (40 CFR 68.22(e)) has defined urban as many obstacles in the immediate area, where obstacles include buildings or trees. Rural, by EPA's definition, means there are no buildings in the immediate area, and the terrain is generally flat and unobstructed. Thus, if your site is located in an area with few buildings or other obstructions (e.g., hills, trees), you should assume open (rural) conditions. If your site is in an area with many obstructions, even if it is in a remote location that would not usually be considered urban, you should assume urban conditions.

Toxic Gases

Toxic gases include all regulated toxic substances that are gases at ambient temperature (25 ^{o}C, 77 ^{o}F), with the exception of gases liquefied by refrigeration under atmospheric pressure and released into diked areas. For the worst-case consequence analysis, you must assume that a gaseous release of the total quantity occurs in 10 minutes. You may take passive mitigation measures (e.g., enclosure) into account in the analysis of the worst-case scenario.

Gases liquefied by refrigeration alone and released into diked areas may be modeled as liquids at their boiling points and assumed to be released from a pool by evaporation (40 CFR 68.25(c)(2)). Gases liquefied by refrigeration alone that would form a pool one centimeter or less in depth upon release must be modeled as gases. (Modeling indicates that pools one centimeter or less deep formed by gases liquefied by refrigeration would completely evaporate in 10 minutes or less, giving a release rate that is equal to or greater than the worst-case release rate for a gaseous release. In this case, therefore, it is appropriate to treat these substances as gases for the worst-case analysis.)

Endpoints for consequence analysis for regulated toxic substances are specified in the rule (40 CFR part 68, Appendix A). Exhibit B-1 of Appendix B lists the endpoint for each toxic gas. These endpoints are used for air dispersion modeling to estimate the consequence distance.

Toxic Liquids

For toxic liquids, you must assume that the total quantity in a vessel is spilled. This guidance assumes the spill takes place onto a flat, non-absorbing surface. For toxic liquids carried in pipelines, the quantity that might be released from the pipeline is assumed to form a pool. You may take passive mitigation systems (e.g., dikes) into account in consequence analysis. The total quantity spilled is assumed to spread instantaneously to a depth of one centimeter (0.033 foot or 0.39 inch) in an undiked area or to cover a diked area instantaneously. The temperature of the released liquid must be the highest daily maximum temperature occurring in the past three years or the temperature of the substance in the vessel, whichever is higher (40 CFR 68.25(d)(2)). The release rate to air is estimated as the rate of evaporation from the pool. If liquids at your site might be spilled onto a surface that could rapidly absorb the spilled liquid (e.g., porous soil), the methods presented in this guidance may greatly overestimate the consequences of a release. Consider using another method in such a case.

Exhibit B-2 of Appendix B presents the endpoint for air dispersion modeling for each regulated toxic liquid (the endpoints are specified in 40 CFR part 68, Appendix A).

Flammable Substances

For all regulated flammable substances, you must assume that the worst-case release results in a vapor cloud containing the total quantity of the substance that could be released from a vessel or pipeline. For the worst-case consequence analysis, you must assume the vapor cloud detonates. If you use a TNT-equivalent method for your analysis, you must assume a 10 percent yield factor.

The rule specifies the endpoint for the consequence analysis of a vapor cloud explosion of a regulated flammable substance as an overpressure of 1 pound per square inch (psi). This endpoint was chosen as the threshold for potential serious injuries to people as a result of property damage caused by an explosion (e.g., injuries from flying glass from shattered windows or falling debris from damaged houses). (See Appendix D, Section D.5 for additional information on this endpoint.)

Effect of Required Assumptions

The assumptions required for the worst-case analysis are intended to provide conservative worst-case consequence distances, rather than accurate predictions of the potential consequences of a release; that is, in most cases your results will overestimate the effects of a release. In certain cases, actual conditions could be even more severe than these worst-case assumptions (e.g., very high process temperature, high process pressure, or unusual weather conditions, such as temperature inversions); in such cases, your results might underestimate the effects. However, the required assumptions generally are expected to give conservative results.

2.2 Determination of Quantity for the Worst-Case Scenario

EPA has defined a worst-case release as the release of the largest quantity of a regulated substance from a vessel or process line failure that results in the greatest distance to a specified endpoint. For substances in vessels, you must assume release of the largest amount in a single vessel. For substances in pipes, you must assume release of the largest amount in a pipe. The largest quantity should be determined taking into account administrative controls rather than absolute capacity of the vessel or pipe. Administrative controls are written procedures that limit the quantity of a substance that can be stored or processed in a vessel or pipe at any one time, or, alternatively, occasionally allow a vessel or pipe to store larger than usual quantities (e.g., during turnaround).

2.3 Selecting Worst-Case Scenarios

Under part 68, a worst-case release scenario analysis must be completed for all covered processes, regardless of program level. The number of worst-case scenarios you must analyze depends on several factors. You need to consider only the hazard (toxicity or flammability) for which a substance is regulated (i.e., even if a regulated toxic substance is also flammable, you only need to consider toxicity in your analysis; even if a regulated flammable substance is also toxic, you only need to consider flammability).

For every Program 1 process, you must report the worst-case scenario with the greatest distance to an endpoint. If a Program 1 process has more than one regulated substance held above its threshold, you must determine which substance produces the greatest distance to its endpoint and report on that substance. If a Program 1 process has both regulated toxics and flammables above their thresholds, you still report only the one scenario that produces the greatest distance to the endpoint. The process is eligible for Program 1 if there are no public receptors within the distance to an endpoint of the worst-case scenario for the process and the other Program 1 criteria are met. For Program 2 or Program 3 processes, you must analyze and report on one worst-case analysis representing all toxic regulated substances present above the threshold quantity and one worst-case analysis representing all flammable regulated substances present above the threshold quantity. You may need to submit an additional worst-case analysis if a worst-case release from elsewhere at the source would potentially affect public receptors different from those affected by the initial worst-case scenario(s).

If you have more than one regulated substance in a class, the substance chosen for the consequence analysis for each hazard for Program 2 and 3 processes should be the substance that has the potential to cause the greatest offsite consequences. Choosing the toxic regulated substance that might lead to the greatest offsite consequences may require a screening analysis of the toxic regulated substances on site, because the potential consequences are dependent on a number of factors, including quantity, toxicity, and volatility.

Location (distance to the fenceline) and conditions of processing or storage (e.g., a high temperature process) also should be considered. In selecting the worst-case scenario, you may want to consider the following points:

- Toxic gases with low toxic endpoints are likely to give the greatest distances to the endpoint for a given release quantity; a toxic gas would be a likely choice for the worst-case analysis required for Program 2 and 3 processes (processes containing toxic gases are unlikely to be eligible for Program 1).

- Volatile, highly toxic liquids (i.e., liquids with high ambient vapor pressure and low toxic endpoints) also are likely to give large distances to the endpoint (processes containing this type of substance are unlikely to be eligible for Program 1).

- Toxic liquids with relatively low volatility (low vapor pressure) and low toxicity (large toxic endpoint) in ambient temperature processes may give fairly small distances to the endpoint; you probably would not choose such substances for the worst-case analysis for Program 2 or 3 if you have other regulated toxics, but you may want to consider carrying out a worst-case analysis to demonstrate potential Program 1 eligibility.

For flammable substances, you must consider the consequences of a vapor cloud explosion in the analysis. The severity of the consequences of a vapor cloud explosion depends on the quantity of the released substance in the vapor cloud, its heat of combustion, and other factors that are assumed to be the same for all flammable substances. In most cases, the analysis probably should be based on the regulated flammable substance present in the greatest quantity; however, a substance with a high heat of combustion may have a greater potential offsite impact than a larger quantity of a substance with a lower heat of combustion. In some cases, a regulated flammable substance that is close to the fenceline might have a greater potential offsite impact than a larger quantity farther from the fenceline.

You are likely to estimate smaller worst-case distances for flammable substances than for similar quantities of most toxic substances. Because the distance to the endpoint may be relatively small, you may find it worthwhile to carry out a worst-case analysis for each process containing flammable substances to demonstrate potential eligibility for Program 1, unless there are public receptors close to the process.